II. <u>REMARKS/ARGUMENTS UNDER 37 C.F.R. §1.111</u>

A. <u>Remarks regarding amendments to the Specification</u>

Paragraph beginning at page 4, line 14 and ending at page 5, line 3:

"At least one" dielectric material is implicit in the phrase "combinations of these materials" at page 12, paragraph [0032], line 2 of the March 15, 2001 Specification.

A dielectric constant "greater than approximately 2" is recited at page 11, paragraph [0031], lines 12-13.

"Ceramics," which are solid materials, and "silicone oil," which is a liquid material, are recited at page 12, paragraph [0032], lines 1-2.

Paragraph beginning at page 7, line 5 and ending at page 7, line 17:

A dielectric constant "greater than approximately 2" is recited at page 11, paragraph [0031], lines 12-13.

The terms "ignite" and "igniting" were used in the March 15, 2001 Specification, while the equivalent term "ignition" was used in the Substitute Specification. This amendment expresses the ordinary meaning of the term in this field.

Paragraph beginning at page 11, line 3 and ending at page 11, line 11:

Corrects a typographical error.

Paragraph beginning at page 13, line 16 and ending at page 14, line 2:

Corrects a typographical error.

Paragraph beginning at page 22, line 4 and ending at page 22, line 8:

Defines the term "re-strike" at page 22, paragraph [0063], line 21 of the March 15, 2001 Specification as synonymous with ignition of the lamp subsequent to its initial ignition.

B. **<u>Remarks regarding amendments to the Abstract</u>**

"At least one dielectric material" is implicit in the phrase "combinations of these materials" at page 12, paragraph [0032], line 2 of the March 15, 2001 Specification.

A dielectric constant "greater than approximately 2" is recited at page 11, paragraph [0031], lines 12-13.

III. CONCLUSION

Applicant requests that these amendments be entered before the application proceeds to issue.

Respectfully submitted,

Dated: December 15, 2003

By /s/

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PATENT
Docket No. PLASLAMP-01
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventors: **Frederick M. Espiau, Yian Chang and Chandrashekhar J. Joshi**

Serial No.: **09/809,718** Art Unit: **2821**

Filed: **March 15, 2001** Examiner: **David H. Vu**

For: **Plasma Lamp With Dielectric Waveguide**

REPLY TO COMMUNICATION MAILED JULY 18, 2003

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Luxim Corporation, Assignee of the above-identified application and hereinafter referred to as Applicant hereby replies under 37 C.F.R. §§ 1.111, 1.121 and 1.141 to the Office communication mailed July 18, 2003 as follows:

Amendments to the Specification, Claims and Abstract are referenced to page, line and paragraph numbers of the application filed on March 15, 2001, rather than to the published application, Pub. No. US 2002/0011802 A1, as in the Reply dated March 6, 2003 and filed on March 11, 2003. Applicant believes that line-by-line comparison of the description originally filed and the amended description set forth in Section I-A below shows that no new matter has been introduced.

Amendments to the Specification begin on page 3 of this paper.

Amendments to the Claims are reflected in the listing of claims which begins on page 26 of this paper.

Amendment to the Abstract is on page 43 of this paper.

Amendments to the Drawings are on page 44 of this paper. Amended drawings were submitted with the Reply of March 6, 2003.

Remarks/Arguments begin on page 45 of this paper.

I. AMENDMENTS UNDER 37 C.F.R. § 1.121-FINAL RULR

A. Amendments to the Specification

Header at pages 1-35: ~~259/014~~ PLASLAMP-01

Please replace paragraphs [0010] - [0015], beginning at page 4, line 18 and ending at page 6, line 14, with the following amended paragraphs:

[0010] This invention ~~generally~~ provides~~, in one aspect, devices and methods of producing bright, spectrally stable light~~ distinct advantages over the electrodeless plasma lamps in the background art, such as brighter and spectrally more stable light, greater energy efficiency, smaller overall lamp sizes, and longer useful life spans. Rather than using a waveguide with an air-filled resonant cavity, the invention uses a waveguide having a body consisting essentially of a solid dielectric material which has a dielectric constant greater than that of air. A larger dielectric constant permits "dielectric waveguides" to be significantly smaller than waveguides of the background art, enabling their use in many applications where the smallest size achievable heretofore has made such use impossible or impractical.

[0011] ~~In accordance with one embodiment as described herein, a device for producing light comprises an electromagnetic energy source, a waveguide having a body formed of a dielectric material, and a bulb. Preferably, the waveguide is connected to the energy source for receiving electromagnetic energy from the energy source. The waveguide builds and contains the electromagnetic energy. The bulb, which is coupled to the waveguide, receives electromagnetic energy from the waveguide. The received electromagnetic energy ignites a gas fill that forms a plasma and emits light, preferably in the visible spectral range.~~ In one aspect of the invention, a lamp includes a waveguide having a body including a ceramic

dielectric material, and a side determined by a waveguide outer surface. The lamp further includes a microwave feed positioned within and in intimate contact with the body which couples energy into the body from a microwave source operating at a frequency within a range of about 0.5 to about 30 GHz. The source operating frequency and intensity and the body shape and dimensions are selected such that the body resonates in at least one resonant mode having at least one electric field maximum. The lamp further includes an enclosed first cavity depending from the waveguide outer surface into the body. Positioned within the cavity is a bulb proximate to an electric field maximum. The bulb contains a gas-fill which when receiving microwave energy from the resonating waveguide body forms a light-emitting plasma.

[0012] ~~In one preferred embodiment, the bulb is shaped to reflect light outwards through its window. The electromagnetic source is preferably a microwave energy source that is efficiently coupled to and preferably thermally isolated from the waveguide. Furthermore, the outer surface of the waveguide, preferably with the exception of the bulb cavity, is coated with a material to contain the microwave energy within the waveguide. The dielectric forming the waveguide preferably has a high dielectric constant, a high dielectric strength, and a low loss tangent. This permits high power densities within the waveguide. A heat sink preferably is attached to the outer surfaces of the waveguide to dissipate heat.~~ In another aspect of the invention, a method for producing light includes the steps of: (a) coupling microwave energy into a waveguide having a body including a ceramic dielectric material and a side determined by a waveguide outer surface with a cavity depending therefrom into the body, the body resonating in at least one resonant mode having at least one electric field

maximum; (b) directing the resonant energy into an envelope determined by the cavity and a window, the envelope containing a gas-fill; and (c) creating a plasma by interacting the resonant plasma with the gas-fill, thereby causing light emission.

[0013] ~~In accordance with a first alternative embodiment, the lamp is operated in resonant cavity mode. In this mode, the microwave energy directed into the waveguide has a frequency such that it resonates within the waveguide. The microwave feed and the bulb are preferably positioned at locations with respect to the waveguide that correspond to electric field maxima of the resonant frequency.~~

[0014] ~~In accordance with a second alternative embodiment, the lamp is operated in a dielectric oscillator mode. In this mode, an energy feedback mechanism or probe is coupled to the dielectric waveguide at a point that in one embodiment corresponds to an energy maximum. The probe senses the electric field amplitude and phase within the waveguide at the point of coupling. Using the probe signal to provide feedback, the lamp may be continuously operated in resonant cavity mode, even if the resonant frequency changes as the plasma forms in the bulb and/or if the dielectric waveguide undergoes thermal expansion due to the heat generated. The probe provides feedback to the microwave source and the microwave source adjusts its output frequency to dynamically maintain a resonance state.~~

[0015] ~~Further embodiments, variations and enhancements, including combinations of the above described embodiments, or features thereof, are also described herein or depicted in the accompanying drawings.~~

Please replace paragraphs [0016] - [0021], beginning at page 6, line 17 and ending at page 7, line 10, with the following amended paragraphs:

[0016] **FIG. 1** illustrates a sectional view of a dielectric waveguide integrated plasma lamp (DWIPL) ~~according to a preferred embodiment~~ including a waveguide having a body consisting essentially of a solid dielectric material, integrated with a bulb containing a light-emitting plasma.

[0017] **FIGs. 2A** and **2B** illustrate sectional views of alternative embodiments of a ~~plasma lamp~~ DWIPL.

[0018] **FIGs. 3A** and **3B** illustrate a sectional view of an alternative embodiment of a ~~plasma lamp~~ DWIPL wherein the bulb is thermally isolated from the dielectric waveguide.

[0019] **FIGs. 4A-D** illustrate different resonant modes within a rectangular prism-shaped dielectric waveguide.

[0020] **FIGs. 5A-C** illustrate different resonant modes within a cylindrical prism-shaped ~~cylindrical~~ dielectric waveguide.

[0021] **FIG. 6** illustrates ~~an~~ a DWIPL embodiment ~~of the apparatus using~~ wherein a feedback mechanism [[to]] provides ~~feedback~~ information to a ~~the~~ microwave source from a feed probing the waveguide field, ~~to maintain~~ thereby dynamically maintaining a resonant mode ~~of operation~~ within the waveguide.

Please replace paragraphs [0022] - [0065], beginning at page 7, line 13 and ending at page 23, line 17, with the following amended paragraphs:

[0022] Turning now to the drawings, **FIG. 1** illustrates a preferred embodiment of a dielectric waveguide integrated plasma lamp ~~101~~ (DWIPL) 101. ~~The~~ DWIPL **101** ~~preferably comprises~~ includes a source **115** of ~~electromagentic~~ microwave radiation, ~~preferably microwave radiation,~~ a waveguide **103** having a body 104 formed of a solid dielectric material, and a microwave feed **117** coupling the radiation source **115** to the waveguide **103**. Waveguide **103** is determined by opposed sides **103A**, **103B**, and opposed sides **103C**, **103D** generally transverse to sides **103A**, **103B**. As used herein, the term "waveguide" generally refers to any device having a characteristic and purpose of at least partially confining electromagnetic energy. As used herein, the term "dielectric waveguide" refers to a waveguide having a body consisting essentially of at least one solid dielectric material. ~~The~~ DWIPL **101** further includes a bulb **107**, ~~that is preferably~~ disposed ~~on an opposing side of the waveguide 103,~~ proximate to side **103A** and preferably generally opposed to feed **117**, ~~and contains~~ containing a gas-fill 108 ~~, preferably comprising~~ including a noble gas and a light emitter, which when receiving ~~electromagnetic~~ microwave energy at a ~~specific~~ predetermined operating frequency and intensity forms a plasma and emits light.

[0023] ~~In a preferred embodiment, the microwave radiation~~ Source **115** ~~feeds the~~ provides microwave energy to waveguide **103** ~~microwave energy~~ via ~~the~~ feed **117**. The waveguide contains and guides the ~~microwave~~ energy to an enclosed cavity **105**, ~~preferably located on an opposing side of the waveguide 103 from the feed 117.~~ depending from side **103A** into body **104**, in which is disposed bulb **107**. ~~Disposed within the cavity 105 is the bulb 107 containing the gas fill. Microwave energy is preferably directed into the enclosed cavity 105, and in turn the bulb 107.~~ This ~~microwave~~ energy ~~generally~~ frees electrons from

~~their normal state and thereby transforms the noble gas into a plasma.~~ noble gas atoms, thereby creating a plasma. The free electrons ~~of the noble gas~~ excite the light emitter. ~~The~~ De-excitation of the light emitter results in ~~the~~ emission of light. As will become apparent, the ~~different embodiments of~~ DWIPL[[s]] embodiments disclosed herein offer distinct advantages over the plasma lamps in the ~~prior~~ related art, such as an ability to produce brighter and spectrally more stable light, greater energy efficiency, smaller overall lamp sizes, and longer useful life spans.

[0024] The microwave source **115** in **FIG. 1** is shown schematically as solid state electronics; however[[,]] other devices commonly known in the art ~~that can operate~~ operating in the 0.5 - 30 GHz range may also be used ~~as a microwave source~~, including but not limited to klystrons and magnetrons. The preferred operating frequency range for ~~the microwave~~ source 115 is from about 500 MHz to about 10 GHz.

[0025] Depending upon the heat sensitivity of ~~the microwave~~ source **115**, the ~~microwave~~ source ~~**115**~~ may be thermally isolated from ~~the~~ bulb **107**, which during operation ~~preferably~~ typically reaches temperatures between about 700°C[[.]] and about 1000°C. Thermal isolation of ~~the~~ bulb **107** from source **115** provides a benefit of avoiding degradation of the source ~~**115**~~ due to heating. Additional thermal isolation of the ~~microwave~~ source ~~**115**~~ may be accomplished by any one of a number of methods commonly known in the art, including but not limited to using an insulating material or vacuum gap occupying an optional space **116** between the source **115** and waveguide **103**. If the ~~latter option is chosen~~ space 116 is included, appropriate microwave feeds are used to couple the ~~microwave~~ source **115** to the waveguide **103**.

[0026] In **FIG. 1**, ~~the~~ feed **117** that transports microwave energy from the source **115** to the waveguide **103** preferably ~~comprises~~ includes a coaxial probe. However, any one of several different types of microwave feeds ~~commonly~~ known in the art may be used, such as microstrip lines or fin line structures.

[0027] Due to mechanical and other considerations such as heat, vibration, aging [[or]] and shock, when feeding microwave ~~signals~~ energy into [[a]] the dielectric material, contact between the feed **117** and waveguide **103** [[is]] preferably is maintained using a positive contact mechanism **121**. The ~~contact~~ mechanism ~~**121**~~ provides a constant pressure ~~between~~ by the feed ~~**117** and~~ on the waveguide to minimize the ~~probability~~ possibility that microwave energy will be reflected back through the feed ~~**117** and not transmitted into~~ rather than entering the waveguide ~~**103**~~. In providing constant pressure, the contact mechanism ~~**121**~~ compensates for small dimensional changes in the ~~microwave~~ feed ~~**117**~~ and ~~the~~ waveguide ~~**103**~~ that may occur due to thermal heating or mechanical shock. ~~The~~ Contact mechanism 121 may be a spring loaded device, such as illustrated in **FIG. 1**, a bellows type device, or any other device commonly known in the art that can sustain a constant pressure for continuously and steadily transferring microwave energy.

[0028] When coupling ~~the~~ feed **117** to ~~the~~ waveguide **103**, intimate contact [[is]] preferably is made by depositing a metallic material **123** directly on the waveguide ~~**103**~~ at its point of contact with the feed ~~**117**~~. ~~The metallic~~ This material ~~**123**~~ eliminates gaps that may disturb the coupling, and [[is]] preferably ~~comprised of~~ includes gold, silver[[,]] or platinum, although other conductive materials may ~~also~~ be used. The ~~metallic~~ material ~~**123**~~ may be

deposited using any one of several methods commonly known in the art, such as depositing the ~~metallic~~ material ~~**123**~~ as a liquid and then firing it in an oven to provide a solid contact.

[0029] In **FIG. 1**, ~~the~~ waveguide **103** is ~~preferably~~ in the shape of a rectangular prism[[,]]. However, the waveguide ~~**103**~~ may ~~also~~ have a cylindrical prism shape, a sphere-like shape, or any other shape~~, including a complex, irregular shape the resonant frequencies of which are preferably determined through electromagnetic simulation tools,~~ that can efficiently guide microwave energy from the feed **117** to the bulb **107**[[.]], including a complex, irregular shape whose resonant frequencies preferably are determined using electromagnetic theory simulation tools. The actual dimensions of the waveguide ~~may~~ will vary depending upon the microwave operating frequency ~~used~~ and the dielectric constant of the ~~body of~~ waveguide body **104**.

[0030] In one preferred embodiment, the waveguide body **104** [[is]] has a volume of approximately 12,500 mm^3 ~~with~~ and a dielectric constant of approximately 9, and [[an]] the operating frequency [[of]] is approximately 2.4 GHz. Waveguide bodies [[on]] of this scale are significantly smaller than the waveguides in the plasma lamps of the ~~prior~~ related art. ~~As such~~ Thus, ~~the~~ waveguides ~~in the preferred embodiments~~ according to the present invention represent a significant advance over the ~~prior~~ related art because ~~the~~ their smaller size allows ~~the waveguide~~ them to be used [[I]] in many applications[[,]] where ~~waveguide size had previously prohibited such use or made such use wholly impractical.~~ the smallest size achievable heretofore has precluded or made wholly impractical such use. ~~For larger dielectric constants,~~ By using materials with larger dielectric constants, even smaller sizes ~~for the waveguides may~~ can be achieved. Besides the obvious advantages ~~created~~ provided by ~~a~~

~~reduction in~~ smaller size, size reduction translates into [[a]] higher power density[[,]] and lower loss, ~~and~~ thereby ~~an ease in igniting the lamp~~ making lamp ignition easier.

[0031] Regardless of its shape and size, ~~the~~ waveguide ~~103~~ body **104** preferably ~~has a body comprising~~ includes a solid dielectric material ~~which, for example, preferably exhibits~~ having the following properties: (1) a dielectric constant ~~preferably~~ greater than approximately 2; (2) a loss tangent less than approximately 0.01; (3) a thermal shock resistance quantified by a failure temperature ~~of preferably~~ greater than approximately 200°C[[.]]; (4) a DC breakdown threshold ~~of preferably~~ greater than approximately 200 kilovolts/inch; (5) a coefficient of thermal expansion ~~of preferably~~ less than approximately 10^{-5}/°C[[.]]; (6) a zero or slightly negative temperature coefficient of the dielectric constant; (7) stoichiometric stability over a ~~preferred range of~~ temperature range ~~preferably from~~ of about -80°C[[.]] to about 1000°C[[.]]; and (8) a thermal conductivity of ~~preferably~~ approximately 2 W/mK (watts per milliKelvin).

[0032] Certain ceramics, including alumina, zirconia, titanates and variants or combinations of these materials~~, and silicone oil~~ may satisfy many of the above preferences, and may be used because of their electrical and thermo-mechanical properties. Alternatively, the dielectric material may be a silicone oil. ~~In any event, it should be noted that the embodiments presented herein are not limited to a waveguide exhibiting all or even most of the foregoing properties.~~ Preferably, body **104** has a substantial thermal mass which aids efficient distribution and dissipation of heat and provides thermal isolation between source **115** and bulb **107**.

[0033] ~~In the various embodiments of the waveguide disclosed herein, such as in the example outlined above, the waveguide preferably provides a substantial thermal mass, which aids efficient distribution and dissipation of heat and provides thermal isolation between the lamp and the microwave source.~~

[0034] ~~Alternative embodiments of DWIPLs **200, 220** are depicted in **FIGs. 2A** and **2B**. In~~ Referring to **FIG. 2A**, ~~a bulb **207** and bulb cavity **205** are provided on one side of a waveguide **203**, preferably on a side opposite a feed **209**, and more preferably in the same plane as the feed **209**, where the electric field of the microwave energy is at a maximum.~~ a DWIPL **200** includes a waveguide **203** having a body **204** consisting essentially of a solid dielectric material, and a side **203A** with an enclosed cavity **205** depending from side **203A** into body **204**. A bulb **207** is disposed within the cavity. DWIPL **200** further includes a microwave feed **209** generally opposed to cavity **205**. Preferably, bulb **207** is in the same plane as feed **209**, where the electric field of the microwave energy is at a maximum. Where more than one maximum of the electric field is ~~provided~~ present in ~~the~~ waveguide **203**, the ~~bulb **207** and bulb cavity **205**~~ cavity and bulb ~~may be~~ are positioned at one maximum and the feed ~~**209**~~ at another maximum. By placing the feed ~~**209**~~ and bulb ~~**207**~~ at ~~a maximum for the electric~~ field maxima, ~~a maximum amount of energy is respectively transferred and intercepted.~~ the amount of energy transferred into the bulb is maximized. ~~The bulb cavity **205** is a concave form in the body of the waveguide **203**.~~

[0035] ~~As shown in~~ Referring to **FIG. 2B**, ~~the body of the waveguide **223** optionally protrudes outwards in a convex form, from the main part of the body of the waveguide **203** to form the bulb cavity **225**.~~ a DWIPL **220** includes a waveguide **223** having a body **224** with a

main portion **224A** consisting essentially of a solid dielectric material. Body **224** further includes a convexly-shaped portion **224B** which protrudes outwardly from portion **224A** to form an enclosed cavity **225**. As in ~~**FIG. 2A**, in **FIG. 2B**,~~ DWIPL **200**, ~~the~~ a bulb **227** ~~is preferably positioned opposite to the feed **221**.~~ disposed within cavity **225** is positioned generally opposed to a microwave feed **221**. ~~However, where more than one electric field maximum is provided in the waveguide **203**, the bulb **207**, **227** may be positioned in a plane other than the plane of the feed **209**, **221**.~~ In contrast to DWIPL **200**, bulb **227** may be positioned in a plane other than the plane of feed **221** where more than one maximum of the electric field is present in waveguide **223**.

[0036] Returning to **FIG. 1**, ~~the outer surfaces~~ sides **103A**, **103B**, **103C**, **103D** of ~~the~~ waveguide **103**, with the exception of those surfaces ~~forming the~~ depending from side **103A** into body **104** which form ~~bulb~~ cavity **105**, are ~~preferably~~ coated with a thin metallic coating **119** [[to]] which reflects ~~the~~ microwaves in the operating frequency range. The overall reflectivity of the coating ~~**119**~~ determines the level of energy ~~contained~~ within the waveguide ~~**103**~~. The more energy that can be stored within the waveguide ~~**103**~~, the greater the ~~overall~~ efficiency of ~~the~~ lamp **101**. Preferably, ~~The~~ coating **119** also ~~preferably~~ suppresses evanescent radiation leakage~~. In general, the coating **119** preferably~~ and significantly ~~eliminates~~ attenuates any stray microwave field(s).

[0037] Microwave leakage from ~~the bulb~~ cavity **105** ~~may be~~ is significantly attenuated by ~~having a~~ choosing the cavity ~~**105** that is preferably~~ dimensions to be significantly smaller than the ~~microwave~~ wavelength(s) of the microwaves used to operate ~~the~~ lamp **101**. For

example, the length of the diagonal ~~for the~~ of a window ~~is preferably~~ sealing the cavity should be considerably less than half [[of]] the microwave wavelength (in free space) ~~used~~.

[0038] Still referring to **FIG. 1**, ~~the~~ bulb **107** ~~is disposed within the bulb cavity 105, and preferably comprises~~ includes an outer wall **109** having an inner surface **110**, and a window **111**. ~~In one preferred embodiment~~ Alternatively, the cavity wall ~~of the body of the waveguide~~ acts as the outer wall of the bulb ~~**107**~~. The components of ~~the~~ bulb **107** preferably include ~~one or more~~ at least one dielectric material[[s]], such as a ceramic[[s]] ~~and~~ or sapphire[[s]]. In one embodiment, the ceramic[[s]] in the bulb ~~are~~ is the same as the material used in ~~waveguide **103**~~ body **104**. Dielectric materials are preferred for the bulb **107** because the bulb ~~**107** is~~ preferably is surrounded by the ~~dielectric body of the waveguide **103**~~ body **104**, and the dielectric materials ~~help ensure~~ facilitate efficient coupling of ~~the~~ microwave energy with the gas-fill **108** in the bulb ~~**107**~~.

[0039] In **FIG. 1**, ~~the~~ outer wall **109** is ~~preferably~~ coupled to ~~the~~ window **111** using a seal **113**, thereby ~~defining~~ determining a bulb envelope **127** which contains the gas-fill **108** ~~comprising the plasma forming gas and light emitter~~. The plasma-forming gas is preferably a noble gas~~, which enables the formation of a plasma~~. The light emitter is preferably a vapor formed of any one of a number of elements or compounds ~~currently~~ known in the art, such as sulfur, selenium, a compound containing sulfur or selenium, or ~~any one of a number of~~ a metal halide[[s,]] such as indium bromide ($InBr_3$).

[0040] To ~~assist in confining~~ confine the gas-fill within the bulb ~~**107**~~, the seal **113** preferably ~~comprises~~ is a hermetic seal. ~~The~~ Outer wall **109** preferably ~~comprises~~ includes alumina because of its white color, temperature stability, low porosity, and coefficient of

thermal expansion ~~coefficient~~. However, other materials that ~~generally~~ provide one or more of these properties may be used. Preferably, ~~The~~ outer wall **109** is ~~also preferably~~ contoured to ~~reflect a maximum amount of light~~ maximize the amount of light reflected out of ~~the~~ cavity **105** through ~~the~~ window **111**. For instance, the outer wall ~~**109**~~ may have a parabolic contour ~~to reflect light generated in the bulb **107** out through the window **111**~~. However, other outer wall contours or configurations that facilitate directing light out through the window ~~111~~ may be used.

[0041] ~~The~~ Window **111** preferably ~~comprises~~ includes sapphire for high light ~~transmittance~~ transmissivity and because its coefficient of thermal expansion ~~coefficient~~ matches well with that of alumina. Alternatively, other materials ~~that have~~ having a similar light transmittance and thermal expansion ~~coefficient~~ properties may be used ~~for the window **111**~~. ~~In an alternative embodiment,~~ Alternatively, ~~the~~ window **111** ~~may comprise~~ includes a lens to collect the emitted light.

[0042] As referenced above, during operation~~, the~~ bulb **107** may reach temperatures of up to about 1000°C. Under such conditions, ~~the waveguide **103** in one embodiment~~ body **104** acts as a heat sink for the bulb ~~**107**~~. By reducing the heat load and heat-induced stress ~~upon~~ on the various ~~components~~ elements of ~~the~~ DWIPL **101**, the lamp's useful life ~~span of the DWIPL **101** is generally~~ can be increased beyond the life span of ~~typical~~ electrodeless lamps in the related art. As shown in **FIG. 1**, effective heat dissipation may be obtained by ~~preferably placing~~ attaching a plurality of heat-sinking fins **125** ~~around the outer surfaces of the waveguide **103**, as depicted in **FIG. 1**.~~ to sides **103A**, **103C** and **103D**. ~~In the embodiment shown in **FIG. 2B**,~~ In DWIPL **220** (see **FIG. 2B**), ~~with the~~ cavity **225** ~~extending~~

extends away from the main ~~part of the body of the waveguide **223**, the DWIPL **220** may be used advantageously to remove heat more~~ portion **224A** of body **224**, allowing heat to be removed efficiently by placing a plurality of fins **222** ~~in closer proximity~~ proximate to ~~the~~ bulb **227**.

[0043] ~~In another embodiment,~~ Alternatively, ~~the body of the waveguide **103**~~ waveguide body **104** ~~comprises~~ includes a dielectric, such as a titanate, which generally is ~~generally not stable~~ unstable at high temperature[[s]]. In ~~this~~ such embodiments, the waveguide **103** is preferably shielded from the heat generated in ~~the~~ bulb **107** by ~~placing~~ interposing a thermal barrier between the body ~~of the waveguide **103**~~ and ~~the~~ bulb ~~**107**~~. ~~In one alternative embodiment,~~ Alternatively, the outer wall **109** ~~acts as a thermal barrier by comprising~~ includes a material with low thermal conductivity, such as an NZP ($NaZr_2(PO_4)_3$) ceramic, which acts as a thermal barrier. ~~Other suitable material for a thermal barrier may also be used.~~

[0044] **FIGs. 3A** and **3B** illustrate ~~an alternative embodiment of~~ a DWIPL **300** wherein a vacuum gap acts as a thermal barrier. As shown in **FIG. 3A**, ~~the bulb **313** of the~~ DWIPL **300** ~~is disposed within~~ includes a bulb **313** disposed within a ~~bulb~~ cavity **315** ~~and~~ which is separated from ~~the waveguide **311**~~ body **312** of a waveguide **311** by a vacuum gap **317**~~, the thickness of which preferably varies depending~~ whose thickness is dependent upon ~~the~~ microwave propagation characteristics and the material strengths of ~~the material used for the body of the waveguide **311** and the bulb **313**.~~ waveguide body **312** and bulb **313**. ~~The gap **317** is preferably a vacuum, minimizing heat transfer between the bulb **313** and the waveguide **311**.~~ The vacuum minimizes heat transfer between the bulb and waveguide.

[0045] **FIG. 3B** illustrates a magnified view of ~~the~~ bulb **313**, ~~bulb~~ cavity **315**[[,]] and vacuum gap **317** ~~for the DWIPL 300~~. The boundaries of ~~the vacuum~~ gap **317** are formed by the waveguide **311**, a bulb support **319**, and ~~the~~ bulb **313**. ~~The bulb~~ Support **319** ~~may be~~ is sealed to the waveguide ~~311, the support 319 extending~~ and extends over the edges of ~~the bulb~~ cavity **315**. ~~and comprising a material such as alumina that preferably has~~ The support includes a material having high thermal conductivity, such as alumina, to help dissipate heat from the bulb ~~313~~.

[0046] Embedded in ~~the~~ support **319** is an access seal **321** ~~for establishing~~ which maintains a vacuum within ~~the~~ gap **317** when ~~the~~ bulb **313** is in place. Preferably, the bulb ~~313~~ is ~~preferably~~ supported by and hermetically sealed to ~~the bulb~~ support **319**. Once a vacuum is established in ~~the~~ gap **317**, heat transfer[[s]] between the bulb ~~313~~ and ~~the~~ waveguide ~~311 are preferably~~ is substantially reduced.

[0047] ~~Embodiments of the DWIPLs thus far described~~ Preferably, DWIPLs **101**, **200**, **220** and **300** operate at a microwave frequency in the range of about 0.5[[-]] to 10 GHz. The operating frequency ~~preferably excites~~ is preselected so as to excite one or more resonant modes supported by the size and shape of the waveguide, thereby establishing one or more electric field maxima within the waveguide. When used as a resonant cavity, at least one dimension of the waveguide is preferably an integer number of half-wavelengths ~~long~~.

[0048] **FIGs.** [[4A-C]] **4A, 4B and 4C** schematically illustrate three ~~alternative embodiments of~~ DWIPLs **410**, **420**, **430**, each operating in a different resonant mode[[s]]. It is to be understood that each of these figures represents DWIPL **101**, DWIPL **200**, DWIPL **220** or DWIPL **300** operating in the respective resonant mode depicted. Referring to **FIG.**

4A, ~~illustrates a~~ DWIPL **410** ~~operating~~ operates in a first resonant mode **411** where the length of one axis of a rectangular prism-shaped waveguide **417** ~~has a length that~~ is one-half the wavelength of the microwave energy used. In **FIG. 4B,** ~~illustrates a~~ DWIPL **420** ~~operating~~ operates in a second resonant mode **421** where the length of one axis of a rectangular prism-shaped waveguide **427** ~~has a length that is~~ equals ~~to one wavelength of~~ the microwave ~~energy~~ wavelength ~~used~~. In **FIG. 4C,** ~~illustrates a~~ DWIPL **430** ~~operating~~ operates in a third resonant mode **431** where the length of one axis of a rectangular prism-shaped waveguide **437** ~~has a length that~~ is ~~1½ wavelengths of the~~ three-halves the microwave ~~energy~~ wavelength ~~used~~. DWIPL **430** includes first and second microwave feeds **433, 434** which supply energy to the waveguide. The feeds may be coupled to a single microwave source or individually to separate sources. DWIPLs **410, 420, 430** further include, respectively, a bulb cavity **415, 425, 435**. As used herein, the term "bulb cavity" refers to the combination of an enclosed cavity and a bulb disposed within the cavity containing a gas-fill including a noble gas and a light emitter, which when receiving microwave energy at a predetermined operating frequency and intensity forms a plasma and emits light.

[0049] In ~~each of the~~ DWIPLs **410, 420, 430,** ~~and corresponding modes depicted in FIGs. 4A-C, and for DWIPLs operating at any higher modes, the~~ bulb ~~cavity~~ cavities **415, 425, 435**, respectively, and ~~the feed(s)~~ feeds **413, 423,** and (**433, 434**), respectively, are preferably positioned with respect to ~~the~~ waveguide[[s]] **417, 427, 437**, respectively, at locations where the electric fields are at an operational maximum. However, the bulb cavity and ~~the~~ feed(s) do not necessarily have to lie in the same plane.

[0050] ~~FIG. 4C illustrates an additional embodiment of a DWIPL 430 wherein two feeds 433, 434 are used to supply energy to the waveguide 437. The two feeds 433, 434 may be coupled to a single microwave source or multiple sources (not shown).~~

[0051] **FIG. 4D** schematically illustrates ~~an additional embodiment of~~ a DWIPL **440** wherein a single ~~energy~~ microwave feed **443** ~~supplies~~ provides energy ~~into the~~ to a waveguide **447** having ~~multiple~~ first and second bulb cavities ~~**415, 416**~~ **445, 446**, each positioned with respect to the waveguide ~~**447**~~ at a location[[s]] where the electric field is at a maximum. It is to be understood that **FIG. 4D** represents DWIPL **101**, DWIPL **200**, DWIPL **220** or DWIPL **300** operating in the resonant mode depicted, but with the DWIPL modified to include two bulb cavities.

[0052] **FIGs.** ~~**5A-C**~~ **5A**, **5B** and **5C** schematically illustrate three DWIPLs **510**, **520**, **530** each having a cylindrical prism-shaped waveguide[[s]] **517**, **527**, **537**, respectively, and operating in a different resonant mode. It is to be understood that each of these figures represents DWIPL **101**, DWIPL **200**, DWIPL **220** or DWIPL **300** operating in the respective resonant mode depicted, but with the DWIPL modified to have a cylindrical waveguide. In ~~the embodiments depicted in FIGs. 5A-C~~ each DWIPL, the height of the cylinder is ~~preferably~~ less than its diameter, and the diameter ~~preferably being~~ is close to an integer multiple of the lowest order half-wavelength ~~of energy~~ that can resonate within the waveguide ~~**517, 527, 537**~~. Placing ~~such a dimensional restriction~~ these dimensional constraints on the cylinder results in the lowest resonant mode being independent of ~~the height of the~~ cylinder height ~~so that the cylinder diameter dictates the fundamental mode of the energy within the waveguide~~. ~~The diameter of the cylinder thereby dictates the fundamental mode of the energy~~

~~within the waveguide **517, 527, 537**. The height of the~~ Cylinder height can ~~therefore~~ thus be optimized for other requirements such as size and heat dissipation. In **FIG. 5A**, ~~the~~ a microwave feed **513** is ~~preferably~~ positioned directly ~~opposite the~~ opposed to bulb cavity **515** ~~and~~ where the zeroeth order Bessel mode **511** is ~~preferably excited~~ a maximum. In **FIG. 5B**, cylindrical waveguide **527** has a diameter close to one wavelength long, so that the first order Bessel mode **521** is excited. Feed **523** is positioned at the field maximum and is diagonally opposed to bulb cavity **525**. In **FIG. 5C**, cylindrical waveguide **537** has a diameter close to three half-wavelengths long so that there are two electric field maxima at which are positioned feeds **533, 534** which provide energy to the waveguide. Bulb cavity **535** is disposed symmetrically between the two feeds. Generally, in a DWIPL having a cylinder-shaped waveguide the cavity and feed(s) are preferably positioned with respect to the waveguide at locations where the electric field is a maximum.

[0053] ~~Other modes may also be excited within a cylindrical prism-shaped waveguide. For example, **FIG. 5B** illustrates a DWIPL **520** operating in a resonant mode where the cylinder **527** has a diameter that is preferably close to one wavelength of the microwave energy used.~~

[0054] ~~As another example, **FIG. 5C** illustrates a DWIPL **520** operating in a resonant mode where the cylinder **537** has a diameter that is preferably close to 1/2 wavelengths of the microwave energy used. **FIG. 5C** additionally illustrates an embodiment of a DWIPL **530** whereby two feeds **533, 534** are used to supply energy to the cylinder-shaped waveguide **537**. As with other embodiments of the DWIPL, in a DWIPL having a cylinder shaped waveguide, the bulb cavity **515, 525, 535** and the feed(s) **513, 523, 533, 534** are preferably positioned~~

~~with respect to the waveguide 517, 527, 537 at locations where the electric field is at a maximum.~~

[0055] ~~Using~~ A dielectric waveguide ~~has~~ provides several distinct advantages. Firstly, as discussed above, the waveguide body ~~may~~ can be used to dissipate ~~the~~ heat generated in the bulb. Secondly, higher power densities ~~may~~ can be achieved within a dielectric waveguide than are possible in ~~the~~ plasma lamps with air cavities ~~that are currently used in the art~~ such as those in present use. ~~The energy density of a dielectric waveguide is greater, depending on the dielectric constant of the material used for the waveguide, than the energy density of an air cavity plasma lamp.~~ Depending on the dielectric constant of the material used for the waveguide body, the energy density of a dielectric waveguide will be somewhat or substantially greater than the energy density in an air cavity waveguide of similar dimensions in a plasma lamp of the related art.

[0056] Referring ~~back~~ again to ~~the DWIPL 101 of~~ **FIG. 1**, high resonant energy within ~~the~~ waveguide **103** of DWIPL **101**, corresponding to a high ~~value for Q~~ Q-value in the waveguide (where Q is the ratio of the operating frequency to the frequency width of the resonance) ~~for the waveguide~~, results in [[a]] high evanescent leakage of microwave energy into ~~the bulb~~ cavity **105**. High leakage [[in]] into the ~~bulb~~ cavity ~~**105**~~ leads to ~~the~~ quasi-static breakdown of the noble gas within ~~the~~ envelope **127**, ~~thus~~ thereby generating the first free electrons. The oscillating energy of the free electrons scales as $I\lambda^2$, where I is the circulating intensity of the microwave energy and λ is the wavelength ~~of that energy~~. ~~Therefore~~ Thus, the higher the microwave energy, the greater is the oscillating energy of the free electrons.

By making the oscillating energy greater than the ionization potential of the gas, electron-neutral collisions result in efficient build-up of plasma density.

[0057] Once ~~the~~ a plasma is formed in ~~the~~ DWIPL **101** and the incoming power is absorbed, the waveguide's Q-value drops due to the conductivity and absorption properties of the plasma. The drop in ~~the~~ Q-value is generally due to a change in the impedance of the waveguide. After plasma formation, the presence of the plasma in the cavity makes the cavity absorptive to the resonant energy, thus changing the ~~overall impedance of the~~ waveguide impedance. This change in impedance is effectively a reduction in the overall reflectivity of the waveguide. ~~Therefore,~~ By matching the reflectivity of the feed to be close to the reduced reflectivity of the waveguide, a sufficiently high Q-value may be obtained even after plasma formation ~~to sustain the plasma~~ so that the plasma is sustained. Consequently, a relatively low net reflection back into the energy source ~~may be~~ is realized.

[0058] Much of the energy absorbed by the plasma eventually appears as heat[[,]] such that the bulb temperature ~~of the lamp~~ may approach 1000°C. When the waveguide is also used as a heat sink, as previously described, the dimensions of the waveguide may change due to ~~its coefficient of~~ thermal expansion. ~~Under such circumstances, when~~ If the waveguide expands, the microwave frequency that will resonate[[s]] within the waveguide changes and resonance is lost. In order for resonance to be maintained, the waveguide ~~preferably has~~ must have at least one dimension equal to an integer multiple of the half-wavelength ~~microwave frequency~~ of the microwaves being generated by ~~the microwave~~ source **115**.

[0059] ~~One preferred~~ A DWIPL embodiment that compensates for ~~this change in dimensions~~ such dimensional changes ~~employs~~ includes a waveguide ~~comprising a dielectric material having a temperature coefficient for its refractive index that is approximately equal and opposite in sign to its temperature coefficient for thermal expansion.~~ having a body consisting essentially of a solid dielectric material with a temperature coefficient for its refractive index that is approximately equal and opposite in sign to its coefficient of thermal expansion. ~~Using such a material, a change in dimensions due to thermal heating offsets the change in refractive index, minimizing the potential that the resonant mode of the cavity would be interrupted.~~ Dimensional changes due to thermal heating are offset by a change in refractive index, thus decreasing the possibility that resonance will be interrupted. Such materials include [[T]]titanates. ~~A second embodiment that compensates for dimensional change due to heat comprises physically tapering the walls of the waveguide in a predetermined manner.~~ Alternatively, dimensional changes due to heating may be compensated for by tapering the walls of the waveguide.

[0060] ~~In another preferred embodiment, schematically shown in~~ **FIG. 6**[[,]] schematically shows a DWIPL **610** ~~may be~~ operated in a dielectric resonant oscillator mode~~.~~ ~~In this mode,~~ wherein first and second microwave feeds **613**, **615** are coupled between ~~the~~ a dielectric waveguide **611**, which may be of any shape previously discussed, and ~~the~~ a microwave energy source **617**. ~~The energy~~ Source **617** is preferably broadband with a high gain and high output power, and is capable of driving the plasma to emission. DWIPL **610** further includes a bulb cavity **619**.

[0061] ~~The first~~ Feed **613** ~~may~~ generally operates as described ~~above in~~ for the other embodiments disclosed herein. ~~The second~~ Feed **615** ~~may~~ probes the waveguide **611** to instantaneously sample the field (including ~~the~~ amplitude and phase information contained therein) ~~present~~, and provides ~~its sample as feedback~~ the sampled field information via a feedback means **612** to an input **617A** of ~~the~~ energy source **617** or to a separate amplifier. In probing the waveguide ~~**611**~~, ~~the second~~ feed **615** also preferably acts to filter out stray frequencies, leaving only the resonant frequency within the waveguide ~~**611**~~. Preferably, feeds **613**, **615** and bulb cavity **619** are each positioned with respect to waveguide **611** at locations where the electric field is at a maximum. Using the sampling information provided by feed **615**, the energy source **617** amplifies the resonant energy within the waveguide. The source thereby adjusts its output frequency to dynamically maintain one or more resonant modes in the waveguide. The complete configuration thus forms a resonant oscillator. In this manner, automatic compensation may be realized for frequency shifts due to plasma formation and changes in waveguide dimensions and dielectric constant due to thermal effects, enabling continuous operation of the lamp.

[0062] ~~In this embodiment, the first feed **613**, second feed, **615** and bulb cavity **619** are each preferably positioned with respect to the waveguide **611** at locations where the electric field is at a maximum. Using the second feed **615**, the energy source **617** amplifies the resonant energy within the waveguide **611**. The source **617** thereby adjusts the frequency of its output to maintain one or more resonant modes in the waveguide **611**. The complete configuration thus forms a resonant oscillator. In this manner, automatic compensation may~~

~~be realized for frequency shifts due to plasma formation and thermal changes in dimension and the dielectric constant.~~

[0063] The dielectric resonant oscillator mode also enables ~~the~~ DWIPL **610** to have an immediate re-strike capability after being turned off. As previously discussed, the resonant frequency of the waveguide ~~**611**~~ may change due to thermal expansion [[or]] <u>and/or</u> changes in the dielectric constant caused by heat generated during operation. When ~~the~~ DWIPL **610** is ~~shutdown~~ <u>shut down</u>, heat is slowly dissipated~~, causing~~ <u>resulting in</u> instantaneous changes in the resonant frequency of the waveguide ~~**611**~~.

[0064] However, as indicated above, in the resonant oscillator mode the energy source **617** automatically compensates for changes in the resonant frequency of the waveguide **611**. Therefore, regardless of the startup characteristics of the waveguide ~~**611**~~, and providing that ~~the~~ energy source **617** has the requisite bandwidth, the energy source ~~**617**~~ will automatically compensate to achieve resonance within the waveguide ~~**611**~~. <u>Thus, t</u>he energy source immediately provides power to the DWIPL at the optimum plasma-forming frequency.

[0065] While <u>several</u> embodiments ~~and advantages of this~~ <u>for carrying out the</u> invention have been shown and described, it ~~would~~ <u>will</u> be apparent to those skilled in the art that ~~many more~~ <u>additional</u> modifications are possible without departing from the inventive concepts <u>detailed</u> herein. ~~The invention~~ <u>It is to be understood,</u> therefore, ~~is not to be restricted except in the spirit of the appended claims.~~ <u>there is no intention to limit the invention to the particular embodiments disclosed. On the contrary, it is intended that the invention cover all modifications, equivalences and alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims.</u>

B. **Amendments to the Claims**

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

Claim 1 (currently amended): A lamp comprising:

(a) a waveguide having a body comprising a ceramic dielectric material of a preselected shape and preselected dimensions, the body having a first side determined by a first waveguide outer surface ~~said waveguide configured to be connected to an energy source for receiving electromagnetic energy~~; ~~and~~

(b) ~~a bulb coupled to the waveguide and containing a gas-fill that emits light when receiving the electromagnetic energy from the waveguide.~~ a first microwave feed positioned within and in intimate contact with the waveguide body, adapted to couple microwave energy into the body from a microwave source having an output and an input and operating within a frequency range from about 0.5 to about 30 GHz at a preselected frequency and intensity, the feed connected to the source output, said frequency and intensity and said body shape and dimensions selected such that the body resonates in at least one resonant mode having at least one electric field maximum;

(c) an enclosed first cavity depending from said first surface into the waveguide body; and

(d) a first bulb positioned in the cavity at a location corresponding to an electric field maximum during operation, the bulb containing a gas-fill which when receiving microwave energy from the resonating waveguide body forms a light-emitting plasma.

Claim **2** (currently amended): The lamp of claim **1**, wherein the ~~body of the~~ waveguide ~~includes~~ <u>has</u> an outer coating ~~comprising an~~ <u>of</u> ~~electrically conductive~~ <u>a metallic</u> material.

Claim **3** (currently amended): The lamp of claim **1**, wherein the bulb comprises ~~a cavity in the body of the waveguide~~ <u>an outer wall having an inner surface</u>, and a window ~~coupled to and~~ covering the cavity.

Claim **4** (currently amended): The lamp of claim **3**, wherein the window is substantially transparent to the ~~emitted~~ light <u>emitted by the plasma</u>.

Claim **5** (currently amended): The lamp of claim **3**, wherein the window ~~is comprised of~~ comprises sapphire.

Claims **6-8** (canceled)

Claim **9** (withdrawn): The lamp of claim **7**, wherein the body of the waveguide includes a main part and a protrusion from the main part, and the cavity is positioned in the protrusion.

Claim **10** (withdrawn): The lamp of claim **3**, wherein the body of the waveguide includes a main part and a protrusion from the main part, and the cavity is positioned in the protrusion.

Claims **11**, **12** (canceled)

Claim **13** (currently amended): The lamp of claim **1**, wherein ~~the~~ said ceramic dielectric material has a dielectric constant greater than ~~approximately~~ about 2[[.0]].

Claim **14** (currently amended) The lamp of claim **1**, wherein ~~the electromagnetic energy has a~~ said operating frequency ~~between~~ is in a range from about 0.5 ~~and~~ to about 10 GHz.

Claim **15** (currently amended): The lamp of claim [[**1**]] 3, wherein the ~~walls of the bulb~~ inner surface of the bulb outer wall ~~are~~ is at least partially reflective of ~~the~~ light emitted by the plasma.

Claim **16** (currently amended): The lamp of claim [[**1**]] 3, wherein the ~~walls of the bulb are shaped~~ inner surface of the bulb outer wall is contoured to reflect ~~the~~ light towards the window.

Claim **17** (currently amended): The lamp of claim [[**1**]] 3, wherein the ~~walls of the~~ bulb outer wall comprises a dielectric material.

Claim **18** (currently amended): The lamp of claim [[**1**]] 17, wherein the dielectric material is a ceramic.

Claim **19** (withdrawn): The lamp of claim **1**, wherein the walls of the bulb thermally isolate the bulb from the waveguide.

Claim **20** (currently amended): The lamp of claim [[**1**]] 3, wherein the ~~window and the walls of the~~ bulb outer wall and window have approximately equal ~~thermal expansion~~ coefficients of thermal expansion.

Claim **21** (canceled)

Claim **22** (currently amended): The lamp of claim [[**1**]] 2, ~~further comprising a heat sink connected to an outer surface of the waveguide~~ wherein a plurality of heat-sinking fins are attached to said metallic outer coating.

Claim **23** (currently amended): The lamp of claim **1**, wherein said shape of the waveguide body ~~has~~ is a rectangular prism[[-]]~~like shape~~.

Claim **24** (withdrawn): The lamp of claim **1**, wherein the waveguide has cylindrical prism-like shape.

Claim **25** (withdrawn): The lamp of claim **1**, wherein the waveguide is sphere-like in shape.

Claim **26** (currently amended): The lamp of claim **1**, ~~further comprising an energy feed coupled to the waveguide for receiving the electromagnetic energy,~~ wherein ~~a positive force mechanism maintains constant contact between the first energy feed and the waveguide~~ <u>the first microwave feed is in intimate contact with the waveguide body via a positive contact mechanism maintaining a constant pressure by the feed on the body</u>.

Claim **27** (currently amended): The lamp of claim **1**, wherein the ~~energy~~ <u>microwave</u> source is thermally isolated from the waveguide <u>body</u> and ~~the~~ bulb .

Claim **28** (original): The lamp of claim **1**, wherein the gas-fill comprises a noble gas and a metal halide.

Claim **29** (withdrawn): The lamp of claim **1**, further comprising a thermal isolation layer disposed between the bulb and the waveguide.

Claim **30** (withdrawn): The lamp of claim **29**, wherein the thermal isolation layer comprises an evacuated space.

Claim **31** (withdrawn): The lamp of claim **1**, wherein an electromagnetic field resonates within the waveguide and includes at least one resonant maximum.

Claim **32** (withdrawn): The lamp of claim **31**, further comprising a first energy feed coupled to the waveguide for receiving the electromagnetic energy, wherein the bulb and the first energy feed are proximate to one of the at least one resonant maximum.

Claim **33** (withdrawn): The lamp of claim **31**, further comprising a first energy feed coupled to the waveguide for receiving the electromagnetic energy, wherein the electromagnetic energy includes at least two resonant maxima and the first energy feed is positioned at a first maximum of the at least two resonant maxima and the bulb is positioned at a second maximum of the at least two resonant maxima.

Claim **34** (withdrawn): The lamp of claim **31**, further comprising first and second energy feeds coupled to the waveguide for receiving the electromagnetic energy, wherein the electromagnetic field includes at least one resonant maxima and the bulb and the first energy feed are proximate to one of the at least one resonant maximum.

Claim **35** (withdrawn): The lamp of claim **31**, further comprising the energy source and a feedback mechanism coupled between the waveguide and the energy source, wherein the feedback mechanism samples the electromagnetic field within the waveguide, transmits the sampled field to the energy source, and the energy source adjusts its delivery of electromagnetic energy to maximize the electromagnetic field detected by the feedback mechanism.

Claim **36** (withdrawn): The lamp of claim **35**, further comprising a first energy feed coupled between the energy source and the waveguide, wherein the electromagnetic energy includes at least one resonant maximum and the first energy feed is positioned approximately at a maximum of the at least one resonant maximum and the bulb is positioned approximately at a maximum of the at least one resonant maximum.

Claim **37** (currently amended): The lamp of claim **1** further comprising the ~~energy~~ <u>microwave</u> source .

Claim **38** (withdrawn): A lamp comprising:

a waveguide comprising a dielectric material and being thermally isolated from and configured to receive electromagnetic energy from an energy source, said waveguide having a protrusion on a first side defining a bulb cavity and an electrically and thermally conductive outer coating on an outer surface of the waveguide except the surface defining the protrusion;

a bulb containing a gas-fill that produces light when receiving the electromagnetic energy, said bulb being at least in part disposed in the bulb cavity and comprising:

(a) a window, the window being substantially transparent to the light, and

(b) an outer wall, the outer wall being hermetically coupled with the window, shaped to direct the light towards the window, and having a thermal expansion coefficient approximately equal to the thermal expansion coefficient of the window, wherein the window and the outer wall define an envelope containing the gas-fill; and

(c) a heat sink coupled to the outer surface of the waveguide.

Claim **39** (withdrawn): The lamp of claim **38**, wherein the electromagnetic energy resonates within the waveguide and comprises at least one resonant maximum, and wherein the bulb cavity and an input of the electromagnetic energy to the waveguide are proximate to the at least one resonant maximum.

Claim **40** (withdrawn): A lamp comprising:

first and second energy feeds for receiving electromagnetic energy from an energy source;

a waveguide having a body comprising a dielectric material, said waveguide being coupled to and for receiving electromagnetic energy from the first energy feed and the second energy feed, having a bulb cavity, and an electrically and thermally conductive coating on the surfaces of the body except the surface defining the cavity;

a bulb containing a gas-fill, said bulb being disposed in the bulb cavity and comprising a window, the window being substantially transparent to emitted light, and an outer wall, the outer wall being hermetically coupled with the window, shaped to direct the light towards the window, and having a thermal expansion coefficient approximately equal to the thermal expansion coefficient of the window, wherein the window and the outer wall define an envelope of the bulb to contain the gas-fill; and

a heat sink coupled to the surface of the waveguide.

Claim **41** (withdrawn): The lamp of claim **40**, wherein the waveguide is configured to contain resonant electromagnetic energy that comprises at least three resonant maxima, the first energy feed being proximate to a first resonant maximum, the second energy feed being proximate to a second resonant maximum, and the cavity being proximate to a third resonant maximum.

Claim **42** (withdrawn): A lamp comprising:

a high frequency electromagnetic energy source having an output port and a feedback port;

an energy feed coupled to the output port to receive electromagnetic energy from the energy source;

a waveguide having a body comprising a dielectric material, said waveguide being coupled to and receiving electromagnetic energy from the energy feed, having a bulb cavity in the body and a reflective outer coating;

a feedback mechanism coupled between the feedback port and the waveguide, the feedback mechanism for sampling the electromagnetic energy within the waveguide and for communicating amplitude and phase of the electromagnetic energy to the energy source, the energy source adjusting its output of electromagnetic energy to maximize the electromagnetic energy detected by the feedback mechanism;

a bulb containing a gas-fill that produces light when excited by the electromagnetic energy, said bulb being disposed in the cavity;

a heat sink coupled to a side of the waveguide.

Claim **43** (withdrawn): The lamp of claim **42**, wherein the electromagnetic energy within the waveguide comprises at least one resonant maximum, the energy feed being positioned at one of the at least one resonant maximum, the feedback mechanism being positioned to sample the resonant field, and the bulb cavity being positioned at one of the at least one resonant maximum.

Claim **44** (withdrawn): A lamp comprising:

at least one energy feed for receiving electromagnetic energy from an energy source;

a waveguide comprising a dielectric material and coupled to the at least one energy feed for receiving electromagnetic energy, said waveguide having a plurality of separate cavities, and an electrically and thermally conductive outer coating deposited on the outer surfaces of the dielectric except the surfaces comprising the plurality of bulb cavities;

a plurality of bulbs containing a noble gas and a light emitter that outputs light when excited by the electromagnetic energy, wherein each of the plurality of bulbs is disposed in one of the plurality of bulb cavities and comprises a window, the window being transparent to the light, and an inner wall shaped to direct the light towards the window and having a thermal expansion coefficient approximately equal to the thermal expansion coefficient of the window, the inner wall being hermetically coupled to the window, the window and the interior wall thereby defining an envelope in which the material is contained; and

a plurality of heat sinks coupled to all sides of the waveguide, said plurality of heat sinks positioned to dissipate heat from the waveguide.

Claim **45** (withdrawn): The lamp of claim **44**, wherein the electromagnetic energy is resonant within the waveguide and comprises a plurality of energy maxima, the at least one energy feed being positioned approximately at at least one of the plurality of energy maxima.

Claim **46** (withdrawn): A lamp comprising:

an electromagnetic energy source;

an energy feed coupled to and receiving electromagnetic energy from the energy source;

a dielectric waveguide thermally isolated from the energy source and coupled to and receiving electromagnetic energy from the energy feed, said waveguide having a cavity and an electrically and thermally conductive outer coating the outer surface of the dielectric material except the surface defining the cavity;

a thermal isolation layer lining the cavity;

a bulb containing a material that produces light when excited by the electromagnetic energy, said bulb being disposed in the cavity, with the thermal isolation layer separating the bulb from the waveguide, and comprising a window, the window being transparent to the light, and an inner wall, the inner wall being hermetically coupled to the window shaped to direct the light towards the window, and having a thermal expansion coefficient approximately equal to the thermal expansion coefficient of the window, the window and the inner wall defining an envelope in which the material is contained; and

a heat sink coupled to an outer surface of the waveguide.

Claim **47** (withdrawn): The lamp of claim **46**, wherein the electromagnetic energy resonates within the waveguide and comprises at least one resonant maximum, the energy feed and the bulb cavity being proximate to the at least one resonant maximum.

Claim **48** (withdrawn): The lamp of claim **46**, wherein the thermal isolation layer comprises an evacuated space.

Claim **49** (withdrawn): The lamp of claim **46**, wherein the thermal isolation layer comprises a second dielectric material.

Claim **50** (currently amended): A method for producing light comprising the steps of:

(a) ~~generating electromagnetic energy~~ coupling microwave energy characterized by a frequency and intensity into a waveguide having a body comprising a ceramic dielectric material of a preselected shape and preselected dimensions, the body having a side determined by an outer waveguide surface and a cavity depending from said surface into the body, said frequency and intensity and said body shape and dimensions selected such that the body resonates in at least one resonant mode having at least one electric field maximum;

(b) directing ~~the electromagnetic energy into a dielectric waveguide having a cavity~~ resonant microwave energy into an envelope determined by the cavity and a window, the envelope containing a gas-fill; and

(c) ~~directing the electromagnetic energy into an envelope defined by the cavity and a window, the envelope containing a gas fill; and~~ creating a plasma by interacting the resonant energy with the gas-fill, thereby causing emission of light.

~~(d) exciting the gas fill into producing light.~~

Claim **51** (currently amended): The method of claim **50** further comprising the step of directing the ~~produced~~ light emitted through the window.

Claim **52** (currently amended): The method of claim **50**, further comprising the step of dissipating ~~the~~ heat generated by the plasma through said ~~the~~ waveguide outer surface ~~of the waveguide~~.

Claim **53** (withdrawn): The method of claim **50**, comprising the steps of:

(e) sampling the levels of electromagnetic energy within the waveguide, and

(f) adjusting the frequency of the electromagnetic energy generated until the sampled electromagnetic energy is at a maximum.

Claim **54** (canceled)

Claim **55** (new): The lamp of claim **1**, wherein the first microwave feed is inserted into the waveguide body through a second waveguide outer surface generally opposed to said first waveguide outer surface.

Claim **56** (new): The lamp of claim **1**, wherein said shape of the waveguide body is a cylindrical prism.

Claim **57** (new): The lamp of claim **1**, wherein said shape of the waveguide body is a sphere.

Claim **58** (new): The lamp of claim **1**, further comprising a space between the microwave source and waveguide body wherein is disposed a thermally insulating material.

Claim **59** (new): The lamp of claim **58**, wherein the space is evacuated.

Claim **60** (new): The lamp of claim **3**, wherein the bulb outer wall thermally isolates the bulb from the waveguide body.

Claim **61** (new): The lamp of claim **1**, wherein the first microwave feed is positioned proximate to an electric field maximum.

Claim **62** (new): The lamp of claim **1**, wherein the waveguide body resonates in a mode having at least two electric field maxima, and the first microwave feed and bulb are positioned proximate to different electric field maxima.

Claim **63** (new): The lamp of claim **1**, further comprising a second microwave feed positioned within the waveguide body.

Claim **64** (new): The lamp of claim **63**, wherein the waveguide body resonates in a mode having at least three electric field maxima, and the first microwave feed, the second microwave feed, and the bulb are each positioned proximate to different maxima.

Claim **65** (new): The lamp of claim **63**, wherein:

(a) the first microwave feed, the second microwave feed, and the bulb are each positioned proximate to an electric field maximum;

(b) the second microwave feed is connected to the microwave source input and probes the waveguide body to instantaneously sample the amplitude and phase of the electric field therein;

(c) the second feed feeds back the sampled amplitude and phase information to the source input; and

(d) the source amplifies the resonant energy within the waveguide body and dynamically adjusts the operating frequency to maintain at least one resonant mode in the body, thereby operating the lamp in a dielectric resonant oscillator mode.

Claim **66** (new): The lamp of claim **61**, further comprising:

(a) an enclosed second cavity depending from said first surface into the waveguide body; and

(b) a second bulb positioned in the second cavity at a location corresponding to an electric field maximum during operation, the bulb containing a gas-fill which when receiving microwave energy from the resonating waveguide body forms a light-emitting plasma.

Claim **67** (new): The lamp of claim **63**, further comprising:

(a) an enclosed second cavity depending from said first surface into the waveguide body; and

(b) a second bulb positioned in the second cavity at a location corresponding to an electric field maximum during operation, the bulb containing a gas-fill which when receiving microwave energy from the resonating waveguide body forms a light-emitting plasma.

Claim **68** (new): The method of claim **50**, further comprising the steps of:

(d) sampling the amplitude and phase of the electric field within the waveguide body; and

(e) adjusting the operating frequency of the microwave source until the sampled electric field is maximized.

C. Amendment to the Abstract

ABSTRACT OF THE DISCLOSURE

A dielectric waveguide integrated plasma lamp (DWIPL) ~~is disclosed for powering a small and bright bulb with a diameter of a few millimeters. The lamp is contained within a high dielectric constant material which guides the microwaves to the bulb, provides heat isolation to the drive circuit, contains the microwaves, provides structural stability and ease of manufacturing and allows efficient energy coupling to the bulb when used as a dielectric resonant oscillator~~ with a body including a ceramic dielectric material having a shape and dimensions such that the body resonates in at least one resonant mode when microwave energy of an appropriate frequency is coupled into the body. A bulb positioned in a cavity within the body contains a gas-fill which when receiving energy from the resonating body forms a light-emitting plasma.

D. Amendments to the Drawings

Amended sheets 1/7, 2/7, 3/7, 5/7 and 7/7 were attached to the Reply dated March 6, 2003, and replace, respectively, original sheets 1/7, 2/7, 3/7, 5/7 and 7/7.

In Figure 1 on sheet 1/7, the following previously omitted elements have been added: 103A, 103B, 103C, 103D (waveguide sides); 104 (waveguide body); 108 (gas-fill); 110 (inner surface).

In Figure 2A on sheet 2/7, the following previously omitted elements have been added: 203A (waveguide side); 204 (waveguide body).

In Figure 2B on sheet 2/7, the following previously omitted elements have been added: 224A (main portion of waveguide body); 224B (convexly-shaped portion of waveguide body).

In Figures 3A and 3B on sheet 3/7, the following previously omitted element has been added: 312 (waveguide body).

In Figure 4D on sheet 5/7, the following previously omitted element has been added: 440 (DWIPL). The following numerals are corrections: 445, 446 (bulb cavities).

In Figure 6 on sheet 7/7, the following previously omitted elements have been added: 612 (feedback means); 617A (input).

II. REMARKS/ARGUMENTS UNDER 37 C.F.R. §1.111

A. Remarks regarding amendments to the Specification

In accordance with MPEP 608.01(d), paragraphs **[0010]** through **[0015]** which constitute the Summary of the Invention are amended to be consistent with amended independent claims **1** and **50** and to reflect withdrawal of independent claims **38**, **40**, **42**, **44** and **46**.

Aside from correction of minor editorial problems, the following substantive changes have been made in the Detailed Description of the Preferred Embodiments:

(a) Additional features of the **FIG. 1** DWIPL, including the body **104** and sides of waveguide **103**, are described and identified by numerals.

(b) paragraph **[0022]** defines the term "dielectric waveguide" to mean a waveguide having a body consisting essentially of at least one solid dielectric material, and recites that bulb **107** is proximate to side **103A** and generally opposed to feed **117**.

(c) paragraphs **[0034]** and **[0035]**, respectively, describe and identify by numerals additional features of DWIPLs **200** and **220**, shown in **FIGs. 2A** and **2B**, respectively.

(d) paragraphs **[0044]**, **[0045]** and **[0046]** describe and identify by numerals additional features of DWIPL **300** shown in **FIGs. 3A** and **3B**.

(e) paragraph **[0048]** clarifies that **FIGs. 4A**, **4B** and **4C** are not separate embodiments but rather show that a DWIPL could operate in each of three different resonant modes.

(f) paragraph **[0051]** clarifies that **FIG. 4D** is a modification of a DWIPL which includes two bulb cavities.

(g) paragraph **[0052]** clarifies that each of the **FIGs. 5A, 5B, 5C** represents **DWIPL 101, 200, 220,** or **300** modified to have a cylindrical waveguide and operating in a particular resonant mode.

(h) paragraph **[0061]** clarifies the description of DWIPL **610** which operates as a dielectric resonant oscillator.

B. <u>Remarks regarding amendments to the Claims</u>

Independent claims **1** and **50** are amended to more particularly point out and distinctly claim the subject matter which Applicant regards as the invention.

In compliance with the Examiner's decision, claims **9, 10, 19, 24, 25, 29-36, 38-49** and **53**, if not canceled, are withdrawn from consideration. However, new claims **55-68** are added, depending from claim **1** or claim **50,** which recite subject matter of withdrawn claims. Under 37 C.F.R. §1.141(a), if claim **1** and/or claim **50** are/is allowed, then claims depending from the allowed claim(s) must also be allowed if they are directed to a "reasonable number" of species.

C. <u>Remarks regarding amendments to the Abstract</u>

The Abstract is amended to better describe the invention in non-technical language.

D. <u>Remarks regarding amendments to the Drawings</u>

Applicant believes that none of the amendments made to Figures 1, 2A, 2B, 3A, 3B, 4D and 6 constitutes new matter.

E. Reply to Examiner's remarks re Information Disclosure Statement

In the Reply dated March 6, 2003, Applicant noted that the Information Disclosure Statement (IDS) filed on June 29, 2001 failed to comply with 37 C.F.R. 1.98(a)(2) which requires: a legible copy of each U.S. and foreign patent; each publication or that portion which caused it to be listed; and all other information or that portion which caused it to be listed. A review of each of the forty-five U.S. patents then listed showed none to be pertinent to the present application in that not one disclosed a waveguide having a body comprising solid dielectric material, let alone was configured to resonate in at least one resonant mode. However, to comply with the rule a copy of each patent was mailed in a separate package at the time the Reply was mailed.

At that time, Applicant also submitted a supplementary IDS listing European Patent Office (EPO) published application EP 0 035 898 and German patent DE 195 32 780 A1, found and considered relevant by the EPO during the search and international preliminary examination phases for application no.: PCT/US01/23745. Copies of these two references were provided. Applicant still does not have a translation of the German patent.

According to the EPO International Preliminary Examination Report, the relevance of these references is as follows:

(a) application EP 0 035 898 discloses: a light source comprising a waveguide configured to be connected to an energy source for receiving electromagnetic energy; and a bulb coupled to the waveguide and containing a gas-fill that emits light when receiving electromagnetic energy from the waveguide. This reference does not disclose a waveguide body made of dielectric material.

(b) patent DE 195 32 780 A1 discloses a waveguide including dielectric material connected to an energy source for receiving electromagnetic energy. However, the waveguide is used in planar semiconductor circuitry. There is no suggestion of using the waveguide in a plasma lamp application to provide microwave energy to a plasma-type bulb or enclosed cavity.

F. <u>Reply to rejection of claims 23-25 under 35 U.S.C. 112, second paragraph</u>

The Examiner rejected claims **23, 24** and **25** under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicant regards as the invention.

Amended claim **23**, which depends from amended claim **1**, recites that the "shape of the waveguide body is a rectangular prism."

Original claims **24** and **25** are withdrawn, but in substance remain in new claims **56** and **57**, respectively, which both depend from amended claim **1** and recite, respectively, that the "shape of the waveguide body is a cylindrical prism," and the "shape of the waveguide body is a sphere."

G. <u>Reply to rejection of claims 1, 3-5, 7-8, 11-12, 14-18, 20, 28, 50-51, 54 under 35 U.S.C. 102(e) as being anticipated by Guthrie '720</u>

The Examiner rejected claims **1, 3-5, 7-8, 11-12, 14-18, 20, 28, 50-51, 54** under 35 U.S.C. 102(e) as being anticipated by C. Guthrie et al. in U.S. Pub. No.: US 2001/0035720 A1 (<u>Guthrie</u> '720).

1. Guthrie '720 does not qualify as Section 102(e) type prior art because the filing date of the application (09/818,092 ("the '092 application)) corresponding to this publication is later than the filing date of the present application (09/809,718 ("the '718 application")). 35 U.S.C. 102(e)(1) states the relevant ground for rejection: "[T]he invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent..." The '718 application was filed on March 15, 2001. The '092 application was filed on March 26, 2001, eleven days later. Since filing a regular application constitutes constructive reduction to practice, the section 102(e)(1) ground does not apply.

2. Assuming, arguendo, that section 102(e)(1) refers to the effective date of a published application, rather than to its actual filing date, Guthrie '720 is not a valid section 120(e) prior art reference because its effective date relies on a provisional application which does not even conceptually disclose the invention, let alone meet the standard of 35 U.S.C. 112, paragraph 1. The '092 application has an effective filing date of March 27, 2000, the filing date of application no. 60/192,731 to Ed Sandberg et al. ("Sandberg '731"), the earliest of nine provisional applications. (A certified copy of this application was submitted with the Reply of March 6, 2003.) Sandberg '731 is the only one of the nine provisionals which antedates our provisional application 60/228,028 ("the '028 application"), filed July 31, 2000, from which the present '718 application claims priority. (A copy of the '028 application as originally filed was submitted with the Reply of March 6, 2003.) Sandberg '731 has almost no commonality with Guthrie '092 because it discloses only

alternative means to improve types of light sources used in "light engines." A light engine is defined therein as a "means for image projection in which the preferred image sources are reflective microdisplays." **FIG. 4.12** schematically shows a plasma lamp or bulb embedded in a ceramic material. The lamp or bulb is within a radio frequency (RF) coil embedded in the material. **FIG. 4.21** shows the **4.12** configuration with the RF coil surrounded by a ferrite. Paragraphs 4.12 and 4.21, at pages 5 and 7, respectively, provide almost no explanation of the concepts the two figures are intended to show. At most these figures show the concept of integrating a plasma lamp and an RF source within a solid dielectric material. The term "plasma style bulb" is used without explanation in paragraph 4.4 at page 3, and "plasma lamp" appears first in paragraph 4.8 at page 4. **FIG. 4.8B** schematically shows a plasma lamp or bulb embedded in a ceramic material and sealed to the environment by a sapphire window within and sealed to the ceramic. **FIG. 4.25** and paragraph 4.25 at page 8 disclose a **FIG. 4.8B**-type plasma lamp or bulb configuration having a tapered "fill hole" and a correspondingly tapered plug. The plug is sealed within the hole using a glass frit or ceramic heated by a laser. In summary, although Sandberg '731 has minor relevance to the invention disclosed in our '028 and '718 applications, there is no mention of a "waveguide," and the central principle of our invention, viz., a solid dielectric waveguide sized to resonate at a preselected operating frequency and integrated with a bulb or enclosed cavity containing a gas-fill which becomes a light-emitting plasma, is not even hinted at.

Except for the use of explanatory legends rather than numerals and leadlines, **FIGs. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10** of our '028 provisional application are identical, respectively, to

FIGs. 1, 2A, 2B, (3A and **3B), 4A, 4B, 4C, 5A, 5B, 5C** of the '718 application. **FIG. 11** of the '028 application is identical to **FIG. 6** of the '718 application except for the absence of an exemplary resonant electric field waveform. **FIG. 12** of the '028 application, which shows the **FIG. 11** "dielectric resonant oscillator" configuration for a "circular puck," (i.e., cylindrical prism) waveguide, is not included in the '718 application. **FIG. 4D** of the '718 application, which shows a single feed providing energy to two bulb cavities, is not included in the '028 application. All the '028 figures are briefly described at page 3, line 9 through page 4, line 16. The embodiments and/or configurations shown in **FIGs. 1** through **11** are described at page 10, line 12 through page 15, line 14.

At page 1, lines 5-7, the '028 application states that the particular field of the invention is "plasma lamps integrated with dielectric waveguides." The term "dielectric waveguide integrated plasma lamp (DWIPL)" is introduced in the brief description of **FIG. 1** at page 3, lines 9-10 and at page 4, line 19. At page 4, line 19 through page 5, line 9, the '028 application discloses that a DWIPL waveguide includes a material having a high dielectric constant "in the range 2 to 140 or greater," which preferably is shaped as a "rectangular or square cross-section slab, a circular puck, or sphere," and further discloses that a plasma lamp according to the invention is preferably made of one or more dielectric materials such as a ceramic and sapphire, and is either embedded inside the dielectric material or protrudes outside of it. At page 6, lines 3-19, the '028 application states that the waveguide preferably is made of "a high dielectric material" having "a low loss tangent, high thermal shock resistance, high breakdown threshold, [a] small coefficient of thermal

expansion, [and a] zero or slightly negative coefficient of [its] dielectric constant. Suitable ceramics are "alumina, zirconia, titanates and their variants." Preferably the lamp is made of alumina and the window is made of sapphire. At page 7, line 18 through page 9, line 7, the '028 application discloses that a dielectric waveguide according to the invention may be operated in a resonant cavity mode, and describes two techniques for compensating for the shift in resonant frequency as the waveguide heats up and its dimensions change. Page 9, lines 8-22 describe criteria for selecting waveguide dimensions and the position(s) of lamp(s) and feed(s) within the waveguide. Page 10, lines 1-10 disclose how a DWIPL may be operated as a dielectric resonant oscillator (DRO).

The '028 application, at page 10, line 12 through page 12, line 13, provides a detailed description of the DWIPL embodiment shown in **FIG. 1**. Disclosed therein are the following features which are disclosed in the detailed description of **FIG. 1** in the '718 application: (a) a dielectric waveguide in the form of a rectangular slab made of a material having a dielectric constant greater than 2; (b) an operating frequency in the 1 - 10 GHz range; (c) a dielectric material which is a ceramic such as alumina, zirconia, or a titanate; (d) a plasma lamp disposed in a cavity in the waveguide; (e) a window made of sapphire hermetically sealed to the waveguide structure; (f) a feed probe maintaining electrical contact and physical "intimate contact" with the waveguide side opposite to the side having the cavity opening; (g) an electrically and thermally highly conductive metallic coating on the outside surface(s) of the waveguide; (h) cooling fins to remove heat generated in the waveguide; and (i) integrated packaging of the DWIPL with a solid state drive circuit. Additional features disclosed at page

12, line 14 through page 15, line 14, and pertinent to at least one of the DWIPL embodiments and/or configurations shown in FIGs. 1 - 12 include: (j) a [cylindrical] waveguide in the shape of a "circular puck"; (k) a DWIPL having a lamp protruding from a waveguide surface; (l) a small vacuum gap separating a plasma lamp from the dielectric material within which it is disposed; (m) a bulb or lamp preferably made of alumina and containing a noble gas and a metal halide; (n) a hermetic seal between a lamp and a sapphire window; (o) feasible positions of a single feed and a lamp cavity or bulb in a resonant rectangular slab or cylindrical waveguide; (p) a DWIPL having two feeds and a single bulb; and (q) a rectangular slab or cylindrical waveguide operated as a DRO.

H. <u>Reply to rejection of claims 1-4, 7, 11-12, 15-18, 20-21, 50-52, 54 under 35 U.S.C. 102(b) as being anticipated by Mucklejohn '258</u>

The Examiner rejected claims **1-4, 7, 11-12, 15-18, 20-21, 50-52, 54** under 35 U.S.C. 102(b) as being anticipated by U.S. Pat. No. 5,086,258 to S.A. Mucklejohn et al. ("<u>Mucklejohn</u> '258").

Currently amended independent claim **1** is distinguishable over <u>Mucklejohn</u> '258 in the following respects:

(a) Claim **1** recites a waveguide having a body comprising a ceramic dielectric material (more generally, a solid dielectric material) configured to resonate when microwave energy of a preselected frequency and intensity is coupled into the body. In contrast, the solid dielectric material in the electrodeless discharge tube disclosed in <u>Mucklejohn</u> '258 does not resonate. Rather, it serves as a structural element and helps in shaping the electric field in the

annular gaps between the outer and inner walls (at column 2, lines 49-53). Mucklejohn '258 does not teach creating an electrical resonance within a mechanical structure.

(b) Claim **1** further recites a bulb in a cavity in the waveguide body, positioned at an electric field maximum and containing a gas-fill which when energized by microwave energy from the resonating body forms a light-emitting plasma. The Mucklejohn '258 tube uses gaps between metallic structures to concentrate the electric field in a surface wave, causing a discharge inside a fill envelope which cannot be formed unless the fill includes a volatile gas which easily breaks down under a relatively low electric field.

Currently amended independent method claim **50** is distinguishable over Mucklejohn '258 in the following respects:

(a) Claim **50** recites coupling microwave energy into a waveguide having a body comprising a ceramic dielectric material and configured to resonate when microwave energy of a preselected frequency and intensity is coupled into the body. Mucklejohn '258 does not teach creating an electrical resonance within a mechanical structure.

(b) Claim **50** further recites directing the resonant energy into an envelope within the body determined by a cavity and a window, and interacting the resonant energy with a gas-fill within the envelope. Again, Mucklejohn '258 does not teach creating resonant energy within a mechanical structure within which the gas-fill envelope is positioned.

Since amended claims **1** and **50** are the only remaining independent claims, it follows that Mucklejohn '258 cannot anticipate any claim depending from claim **1** or claim **50**.

I. <u>Reply to rejection of claims 2, 21, 52 under 35 U.S.C. 103(a) as being unpatentable over Guthrie '720 in view of Mucklejohn '258</u>

The Examiner rejected claims **2**, **21**, **52** under 35 U.S.C. 103(a) as being unpatentable due to obviousness over <u>Guthrie</u> '720 in view of <u>Mucklejohn</u> '258.

Applicant has already shown that <u>Guthrie</u> '720 is not a valid prior art reference, and that currently amended independent claim **1** from which claims **2** and **21** depend, and currently amended independent claim **50** from which claim **52** depends are novel and nonobvious over <u>Mucklejohn</u> '258.

J. <u>Reply to rejection of claims 6, 13, 22-23, 26-27 under 35 U.S.C. 103(a) as being unpatentable over Guthrie '720</u>

The Examiner rejected claims **6**, **13**, **22**, **23**, **26**, **27** under 35 U.S.C. 103(a) as being unpatentable due to obviousness over <u>Guthrie</u> '720.

Again, Applicant has shown that <u>Guthrie</u> '720 is not a valid prior art reference.

K. <u>Reply to rejection of claims 5, 13-14, 22-23, 26-28 under 35 U.S.C. 103(a) as being unpatentable over Mucklejohn '258</u>

The Examiner rejected claims **5**, **13**, **14**, **22**, **23**, **26**, **27**, **28** under 35 U.S.C. 103(a) as being unpatentable due to obviousness over <u>Mucklejohn</u> '258.

Again, Applicant has shown that currently amended independent claim **1** is novel and nonobvious over Mucklejohn '258, so any claim depending from claim **1** must be novel and non-obvious.

III. CONCLUSION

By the above amendments to claims **1** and **50** and claims depending therefrom, Applicant expressly denies that any estoppel has been created as related to any other combination or sub-combination of structural elements or method steps, respectively. The above amendments were made not only for the purpose of overcoming the teachings of Mucklejohn '258, but were also made to more clearly set forth the claimed subject matter, and to set forth more limitations than necessary to render the claims patentable over the prior art in order to obtain allowance at the next examination. By the present amendments Applicant intends to obtain a patent as soon as possible on inventive subject matter, even though the claims do not represent the broadest possible subject matter that Applicant has a right to claim. Rather, Applicant intends to pursue such broader subject matter in claims to be presented in future continuation-type applications.

For all the above reasons, Applicant believes all grounds for the Examiner's rejections have been overcome and again respectfully requests allowance of all claims now pending.

In view of the 5 month delay within the Patent Office in beginning to process the Reply dated March 6, 2003, Applicant also requests expedited examination of the arguments and amended claims.

Respectfully submitted,

Dated: August 8, 2003

By /s/

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